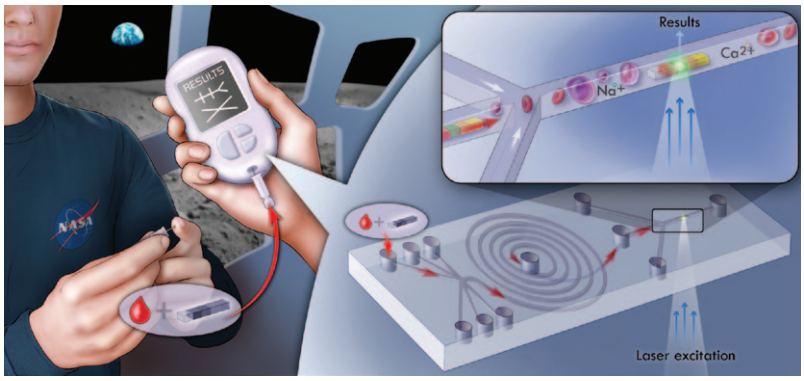
National Aeronautics and Space Administration

The rHEALTH Sensor

Universal biomedical analysis sensor shrinks hospital lab to single POC device



The rHEALTH sensor is a self-contained, comprehensive general-purpose assay system to analyze bodily fluids

A unique collaboration between NASA's Glenn Research Center and the DNA Medicine Institute (DMI) has produced a reusable microfluidic device that performs rapid, low-cost cell counts and measurements of electrolytes, proteins, and other biomarkers. The reusable Handheld Electrolyte and Lab Technology for Humans (rHEALTH) sensor is a compact portable device that employs cutting-edge fluorescence detection optics, innovative microfluidics, and nanostrip reagents to perform a suite of hematology, chemistry, and biomarker assays from a single drop of blood or bodily fluid. Developed to monitor astronaut health on the International Space Station (ISS) and during long-term space flight, terrestrial applications for this ground-breaking technology include point-of-care (POC) diagnostics at a patient's bedside, in a doctor's office, or hospital. This revolutionary microscale lab analysis tool was developed with funding from NASA's Small Business Innovation Research (SBIR) program.

Benefits of Technology Transfer

- Efficient flow-based detection technology allows a range of samples to be counted, analyzed, and measured.
- The use of reusable microfluidics reduces device mass and volume, enabling a handheld portable device (8 x 4 x 0.5 in^3) that does not rely on single-use disposable components.
- This revolutionary technology is expected to contribute significantly to the evolving needs of space medicine, biomedical research, POC diagnostics, and environmental monitoring.
- Sustained and reliable performance will result in a multi-year lifetime in a low-gravity environment characterized by radiation, low humidity, and lack of refrigeration.
- Innovative use of nanostrip reagents will enable massive multiplexing that has the potential to allow hundreds of measurements from a single session.

success

On the Record

"Dr. Chan has brought a unique competence to this collaboration along with a desire to create something meaningful for NASA's space missions. For decades, the Holy Grail of portable biomedical diagnostics research has been the creation of a device that could measure dozens or hundreds of biomarkers from a tiny bit of biosample. The rHEALTH and nanostrip technologies not only have the greatest potential to finally achieve this objective, they are likely to actually reach this goal."
—Dr. Emily Nelson, Senior Research Engineer, NASA Glenn Research Center

"The interaction with NASA has been wonderful. The team brought significant capabilities and a deep expertise in flight-worthniess, computational fluid modeling, and testing. Through these interactions, we have been able to attain a much better instrument than otherwise possible. The potential for clinical applications here on Earth is significant."
—Dr. Eugene Chan, DMI Founder, President, and Chief Scientific Officer

About DNA Medicine Institute

Based in Cambridge, Massachusetts, DMI seeks to advance patient care and treat disease through innovation. The firm draws upon diverse and disparate fields including medicine, nanotechnology, genomics, biophysics, biochemistry, molecular biology, and advanced engineering. Currently, DMI is researching intuitive medical devices, smartly designed drugs, and powerful research instrumentation.

Technology Origins

As NASA plans for long-duration spaceflight, the need for compact, reliable, lightweight diagnostics will be critical for monitoring crew health. A handful of current portable POC devices provide generalized blood analysis but perform only a few tests at a time and rely on disposable components and diverse detection technologies to complete routine tests – all ill-suited for space travelers on extended missions. In contrast, the rHEALTH sensor integrates sample introduction, processing, and detection with a compact, resource-conscious, and efficient design. The device's unique capabilities are enabled by a combination of microfluidics, high-sensitivity fluorescence optics, and nanostrip reagents.

The sensor employs a microfluidic chip that is flow-based so that samples can be pumped through the device, allowing the chip to be cleaned for subsequent use thereby eliminating the potential for cross-contamination. Central to its operation is a state-of-the-art highly efficient means of microfluidic mixing. The reusable platform minimizes cost and obviates the need for consumables, making the technology ideal for long space flights. The device's use of optical fluorescence to measure electrolytes, biomarkers, and other analytes supplies a single detection modality and in theory can extend the device's capabilities from cell counting to visual examination of plant cultures and water samples. Massive multiplexing is attained through the device's innovative use of nanostrip reagents. Nanostrips are conceptually similar to the standard urinalysis test strip, but in this case the strips are shrunk down a billion-fold to the micron scale. Each nanostrip can have several sensor pads that fluoresce in response to different targets in the sample.

The Transfer Process

The collaborative work for this remarkable biodiagnostic device was accomplished through a series of SBIR contracts involving NASA's Glenn Research Center and Johnson Space Center beginning in 2008. In September 2010, the NASA-DMI team successfully completed reduced-gravity experiments on the rHEALTH sensor as part of NASA's Facilitated Access to the Space Environment for Technology (FAST) program. The device performed well, and DMI was recently awarded a pair of Phase 3 SBIR contracts to proceed with system development, including hardware integration and design, chip design, detection capabilities, software development, nanostrip fabrication, and assay development. Glenn is providing its expertise in microgravity fluid physics, microfluidics, and numerical modeling to examine design issues and fouling potential. In addition, Glenn is facilitating discussions with the Food and Drug Administration (FDA) to ascertain FDA requirements for the use of the rHEALTH sensor as a biomedical research and/or diagnostic tool.

Gearing Up for Commercialization

DMI plans to commercialize the rHEALTH sensor and is working to form a partnership with a diagnostics firm. Potential applications include biomedical research, POC diagnostics, and health monitoring in clinical settings.

For More Information

If you would like additional information about Glenn's technology transfer opportunities, please contact:

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